SRM UNIVERSITY
(Under section 3 of UGC Act 1956)

ELECTROSURGICAL UNIT

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Contents

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- Principle of ESU
- Application
- Types of ESU
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- Operation
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Introduction & History

- Cautry
- Surgical Unit

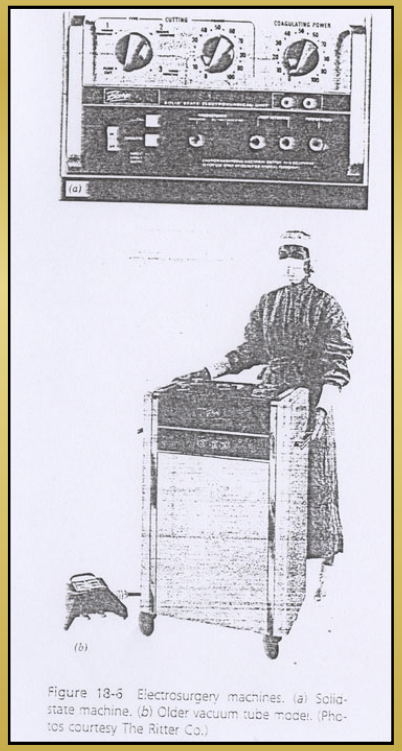


Figure 18-6 Electrosurgery machines. (a) Solid-state machine. (b) Older vacuum tube model. (Photos courtesy The Ritter Co.)

Electricity

- Electricity is the fundamental phenomenon in nature seen in the attractions and repulsions of oppositely charged objects and utilized as a source of energy ion the form of a current
- <u>Properties of electricity</u>
  - Electricity, which moves at nearly the speed of light, will
    (1) always follow the path of least resistance
    (2) Always seeks the closed path

Current

- Current is the movement of an electrical charge (electrons or ions) through a circuit.
- It is measured in Ampere.
- There are two types of current
  - Alternating current (AC)
  - Direct Current (DC)

Impedance / Resistance

- It is the opposition to the flow of current
- It is measured in Ohms Ω
- During Electrosurgery, the patient acts as impedance.

Voltage

- Voltage is the force that causes a current to flow in an electrical circuit.
- It is measured in volts

Power

- Power is the rate at which energy is supplied.
- The energy is measured in watts (W).
- Power = Voltage x Current

  P = V I

History

- **1875 – Electric current was passed through wire loop until they were red hot and heat was transferred to tissue by contact with the red hot wire**

- **The ESU developed by Cushing and Bovie was a spark-gap unit that consisted of two small metal conducting pieces separated by an air gap. It worked like the familiar automobile spark plug. When voltage rises enough to jump across the air gap, the air becomes ionized and functions as a conductor.**

History

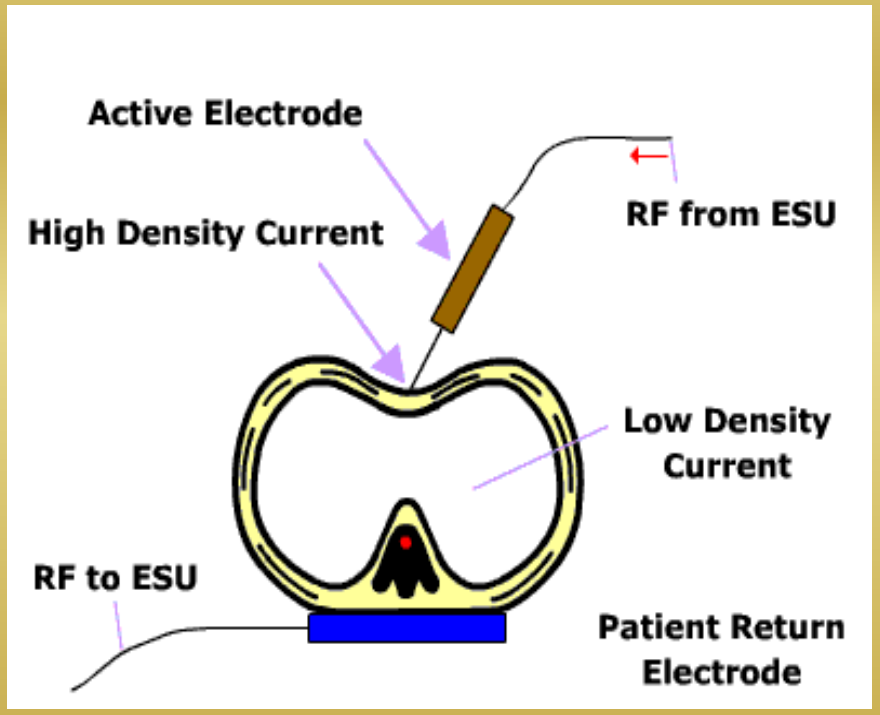
- 1924 – Ground reference generator by Dr. Harvey Cushing and Bovie
- 1970 – solid state generator
- 1980 – Argon Electrosurgery

History

- **Founder - Dr. Harvey Cushion and William Bovie.**

Principle

- Active Electrode – High Current Concentration
- Dispersive Electrode – Low Current and Heat dissipates
- Current concentration or density depends on the size of the area through which the current flows.



Definition of “Electrosurgery”

- **Electrosurgery is a simple, well proven, method of making surgical incisions, control bleeding and destroying unwanted tissue cells by the use of a high frequency "electrosurgical current".**

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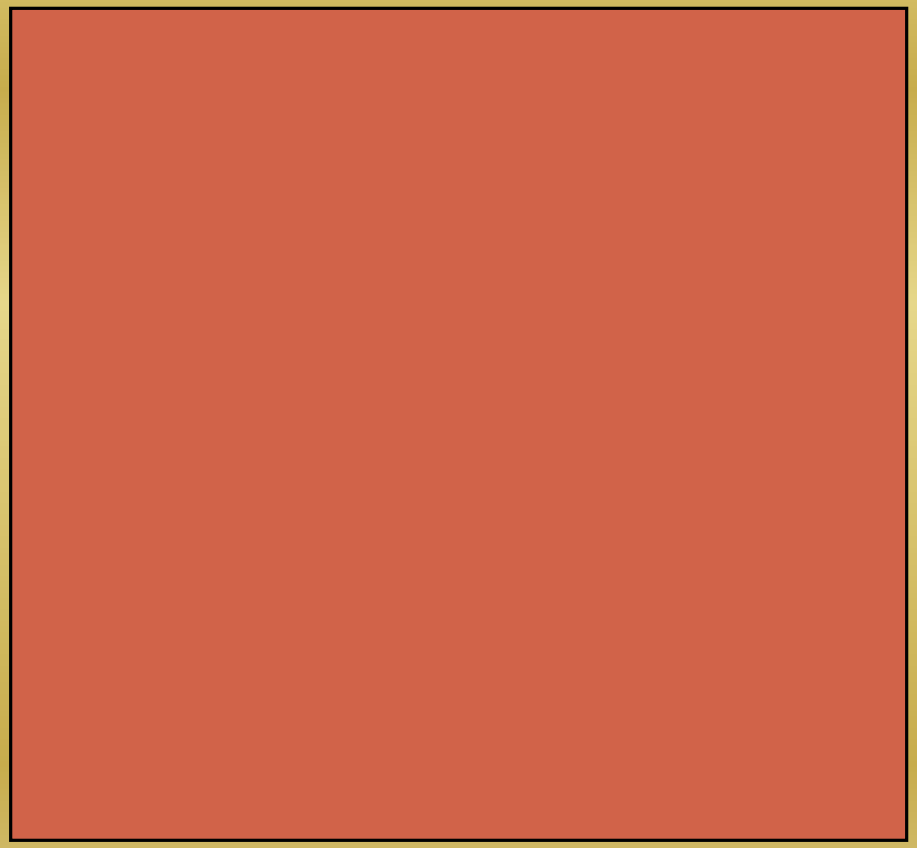
Confusion……??

- **Electro Cautery Unit**
- **Electro Surgical Unit**

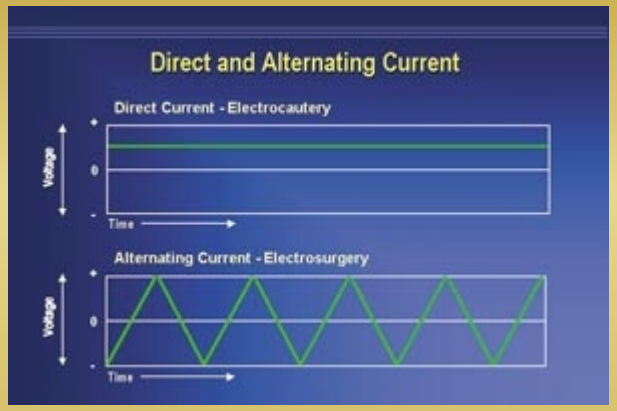
Electrocautery

- A high amount of current is passed through the electrode and burning or coagulation is achieved
- Electrode for Cautery – Scalpel, Wire
- Only particular organ or tissue is targeted
- It is a Direct Current (DC) Source

Electro Surgical Unit

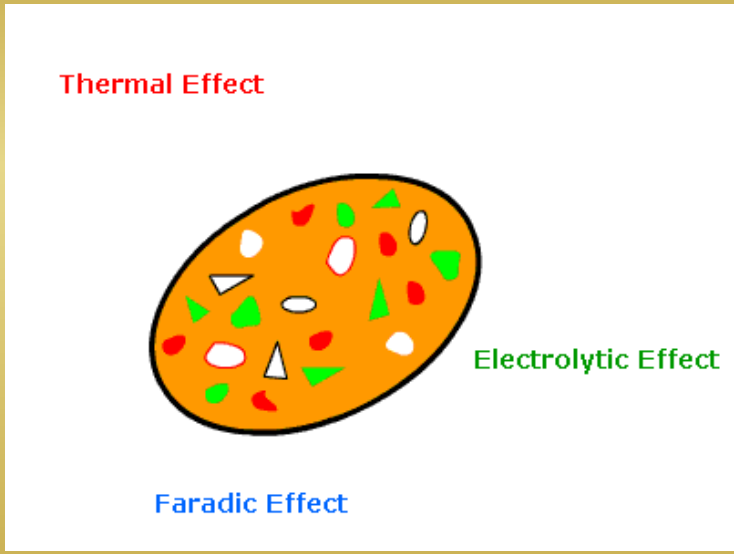


- A high frequency Current flows through active electrode (AC source)
- Cell ruptured- fumes or evaporates
- Return path through Dispersive Electrode
- Patient is included in circuit


Direct and Alternating Current
Direct Current - Electrocautery
Voltage
+
0
-
Time
Alternating Current - Electrosurgery
Voltage
+
0
-
Time

Effect of RF current on Cell

- When a high frequency current is applied to the tissues, the tissue gets torn apart and gets the following effects
- Thermal Effect
- Electrolytic Effect and
- Faradic Effect



Application

- Electrocautery is used in surgery to burn unwanted or harmful tissue. Also used to stop hemorrhage.
- Widely used in Operation Room to perform surgical operation on patient.
- Most suitable for delicate Neurosurgery, Plastic Surgery and Ophthalmic Surgery.

Application

- To remove small lesions, moles, fungus, bacteria, hair follicles.
- Ophthalmic, Neurology, ENT (To stop Nose Bleeding), Gynecology, Dermatology
- Laparoscopy and Trans Urethral resection of Prostate (TURP)
- Organs - Liver, Spleen, Thyroid, Lungs and Heart Surgery

Operating Frequency

- The frequency of operation of solid state surgical diathermy machine is 300KHz – 3MHz
- {Ex- Load of 500Ω, output 400W i.e about 2000 Volt in cutting mode and 150 W in Coagulation mode.}

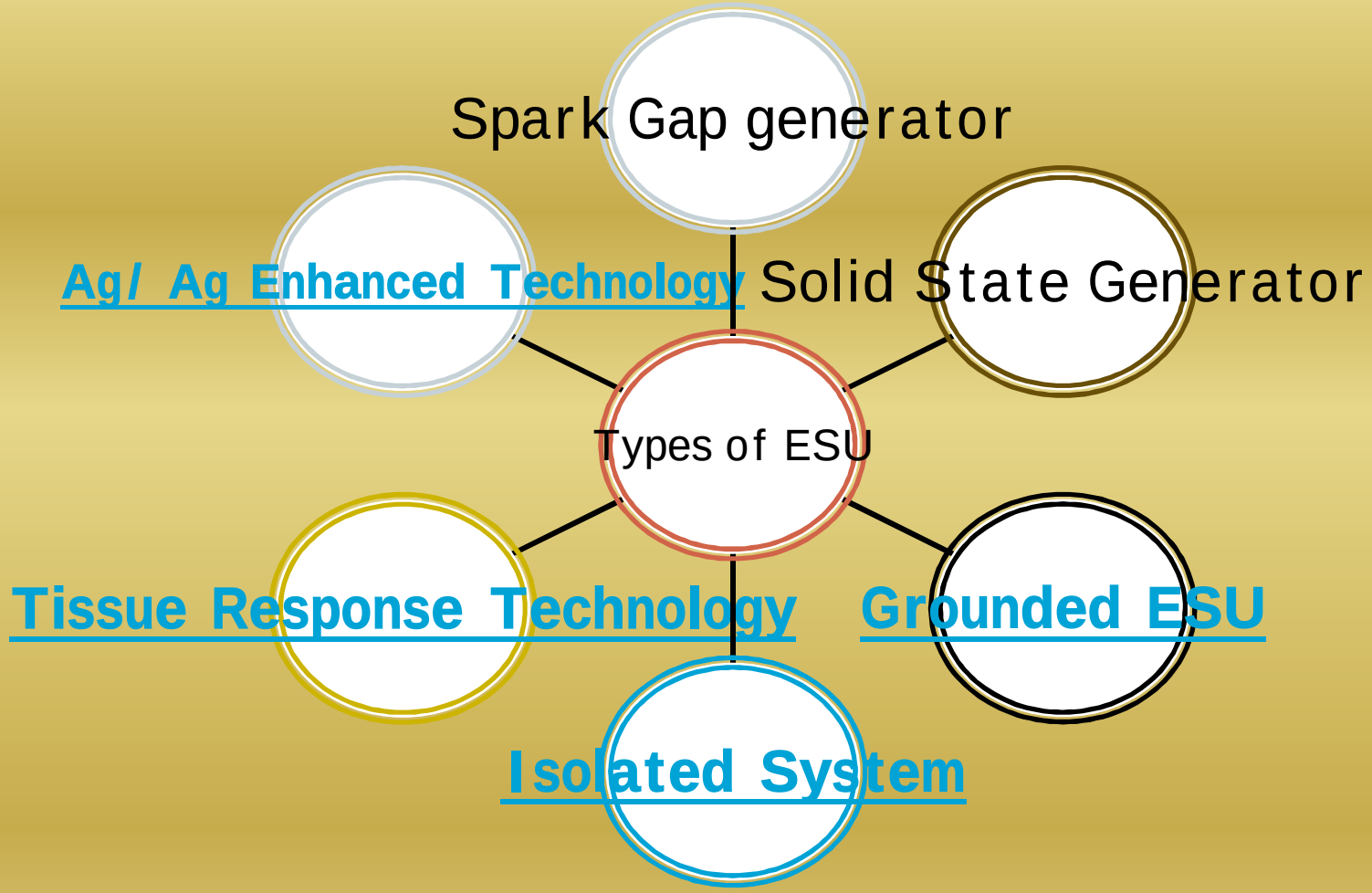
Types of ESU

Spark Gap Generator

- Transistor circuits
- Vacuum Tubes
- Less safety for handling

Solid State Generator

- Transistor Based Amplifier
- Oscillator Circuit
- Modified waveform- Blend Waveform
- High safety


Spark Gap generator
Ag/ Ag Enhanced Technology
Solid State Generator
Types of ESU
Tissue Response Technology
Grounded ESU
Isolated System

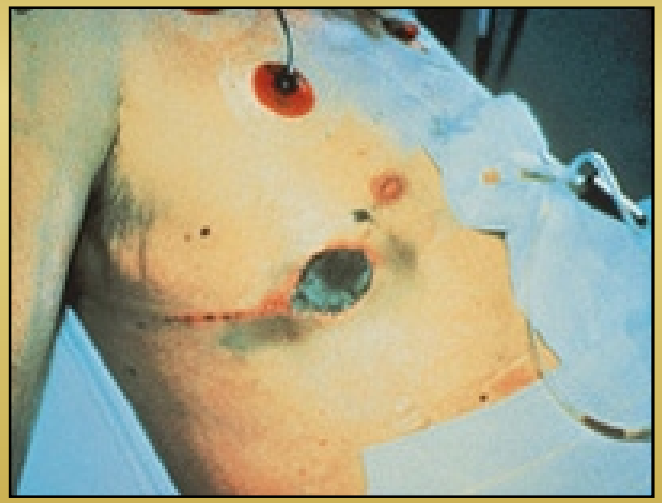
Grounded ESU

- **Older generation**

  No Return Electrode causes patient skin burn

- **Electrode placement**

  ECG Electrodes have least resistance to ground so site burn at electrode placement



Grounded ESU

- Current seeks shortest return path to ground so by bed side monitor, operating table or any conductive path
- Alternate site burns related to current taking pathway of least resistance to ground
  - Patient return electrode site burns
  - Insulation failure injuries
  - Capacitive coupling injuries

Isolated System

- Return Electrode introduced in solid state generator
- Advantage – No possibility of patient skin burn
- Detects for return electrode attachment
- Measures patients impedance

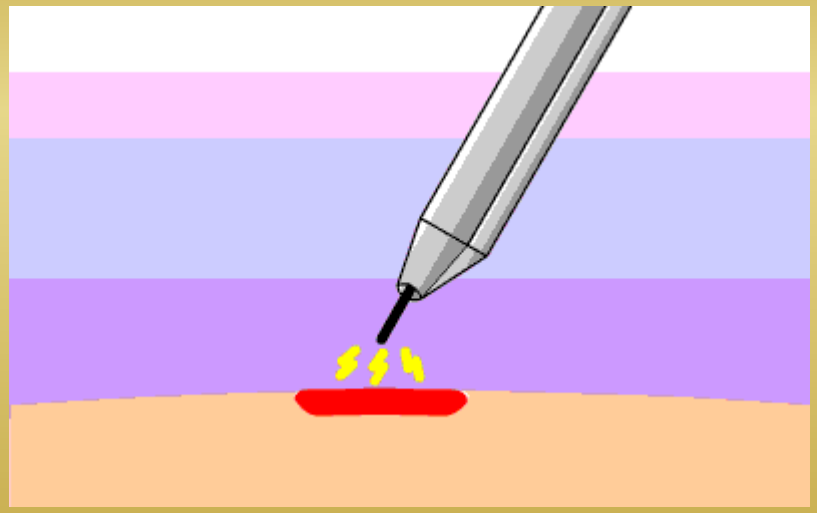
Recent Technology

Tissue Response Technology

- It uses a computer-controlled tissue feedback system that senses tissue impedance (resistance) and automatically adjusts the current and output voltage to maintain a consistent surgical effect.
- Advantage - Reduces the need to adjust power settings for different types of tissue.
- It also gives improved performance at lower power settings and voltages, which helps to reduce the risk of patient injury.

Argon/Argon Enhanced Technology

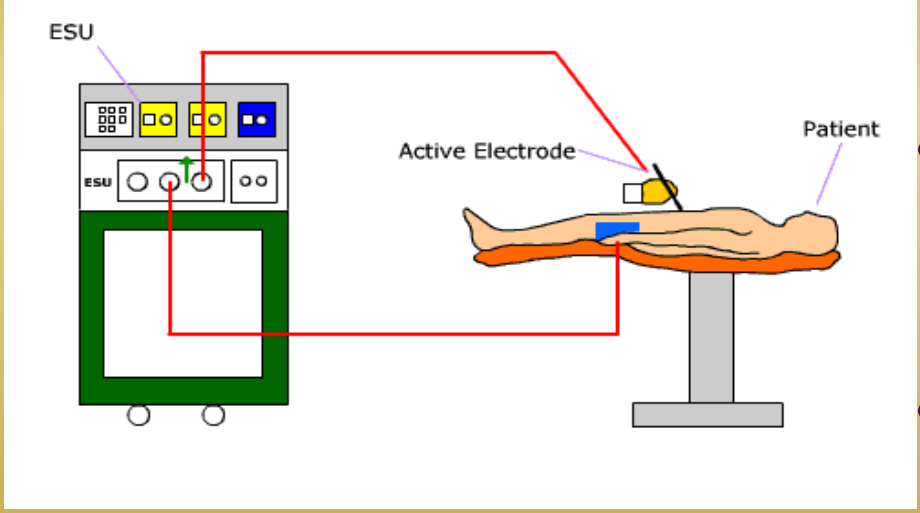
- Argon Gas in Electrosurgery
- Argon Gas Properties
  - Inert Gas
  - Non combustible
  - Easily ionizes
  - Displays the blood to visualize surgical site
  - Less smoke
  - It produces a beam like manner and creates bridge between electrode and tissue.



Modes of Electrosurgery

- –Monopolar Surgery
- –Bipolar Surgery

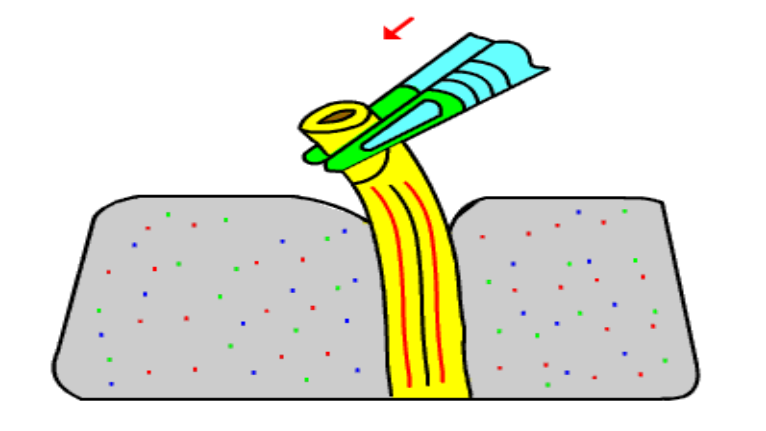
Monopolar Surgery

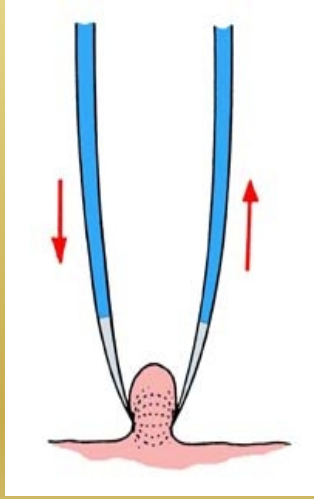


- RF current flows through ESU and Active Electrode
- Returns to ESU through Return Electrode.
- Used for cut and coagulation.

Bipolar Electrosurgery

- Output current flows via BIPOLAR electrode in one terminal
- Returns the current through another terminal
- It is much safer than Monopolar surgery
- Used for cut and coagulation too.





Advantages of Bipolar

- It is much safer than Monopolar
- RF current flows only through well defined area, while in Monopolar current flows back through large section of patient body
- Risk of patient touch is low
- Less Interference for other instruments
- No ‘patient plate’ or ‘Return electrode’ is required

Electrode

- There are two types of Electrodes used in Electrosurgery

  1. Active Electrode

  2. Dispersive Electrode.

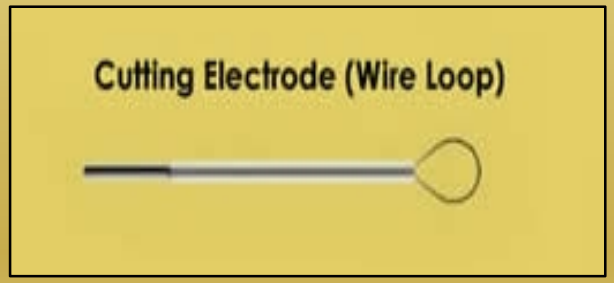
Active electrode

- There are two types of Active Electrode
  - Cutting Electrode
  - Coagulation Electrode

Cutting Electrode

- **Cutting Electrode** – They are available in different shapes (Angulated, Needle or wire loop shape)

Wire Loop Electrode

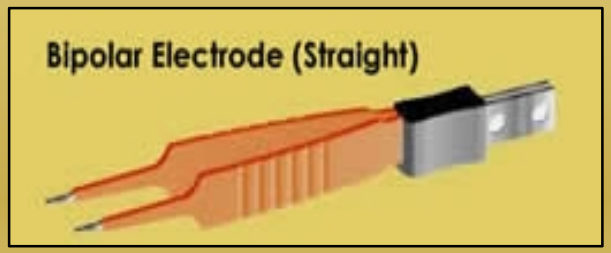


Angulated Electrode

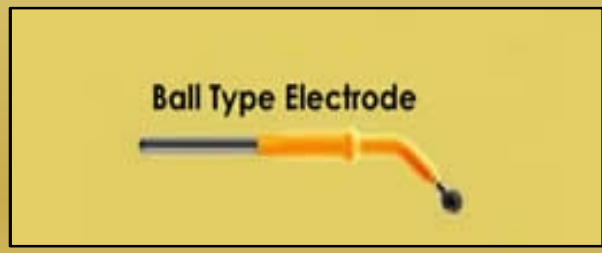
Coagulation Electrode

- These are available in the blunt shape, ball shape or Bipolar type. The density area of this electrode is bit larger than cutting electrode.

Bipolar Electrode



Ball Type Electrode



Dispersive / Passive Electrode

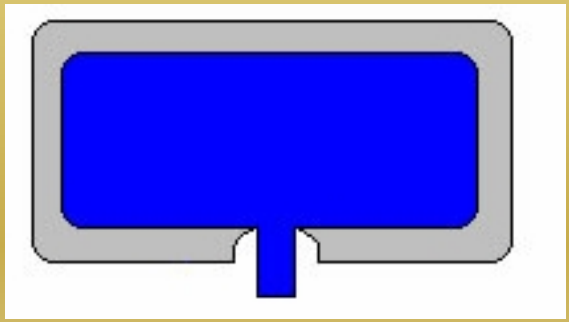
- It is also called as '*Indifferent Electrode*' or '*Patient Return Electrode*'

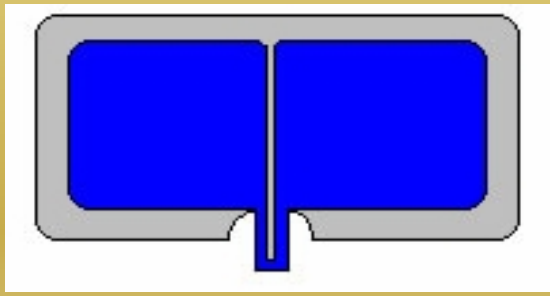
- Patient return electrodes remove electrical current from the patient by completing the patient / generator circuit.

Dispersive / Passive Electrode

- Lead (Metal) plate wrapped in wet cloth bag.
- Disposable Type Electrode.
- Area should be larger than active electrode about more than 100cm²

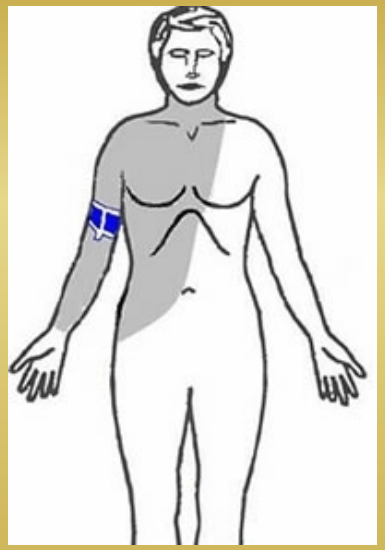
Single Contact Surface **Double Contact Surface.**

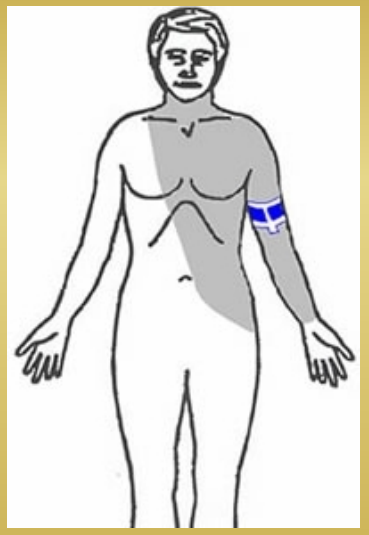




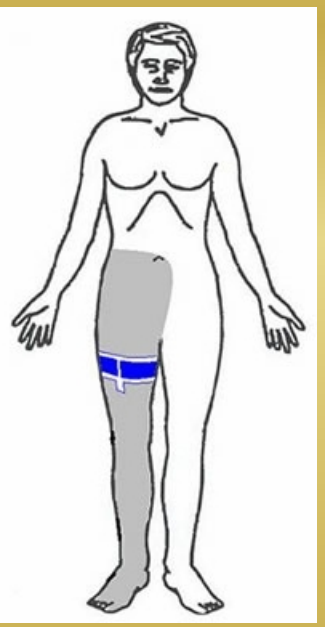
Placement and area of affect

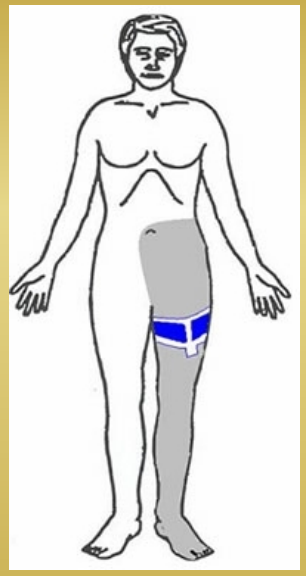
- The patient becomes the part of electronic circuit
- As the current seeks for shortest and less resistive path to ground, user should be aware that position of patient return electrode should be as shorter as possible.





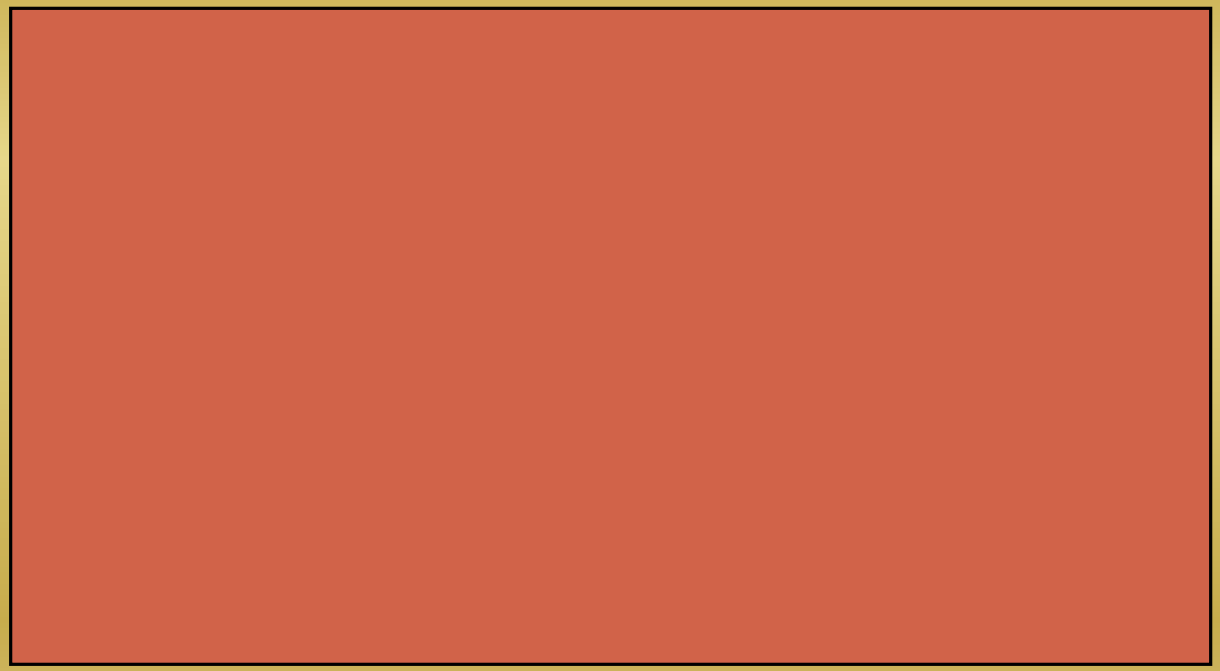
Placement and area of affect





- If a return electrode is placed far from the operating task, the current has to travel a long distance, resulting increase in the power setting.
- Accidentally, if any part of the patient body touches to ground, a burn effect will occur at that site.
- Ideally the arms or muscular abdomen can be a suitable site for placement of patient return electrode.

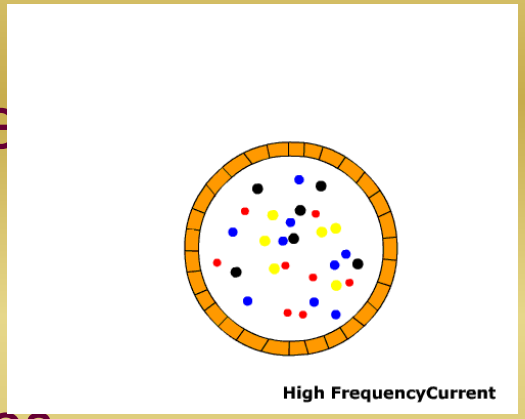
Modes of Electrosurgery



Electrotomy / Cutting

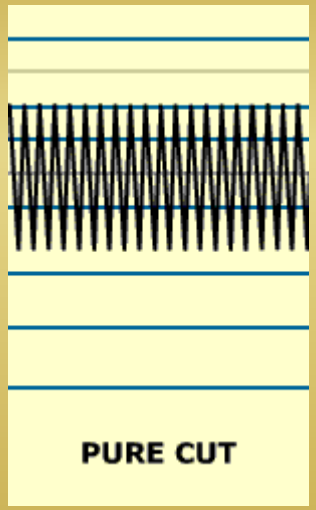
- Tissue gets heated and tissue ce
  explodes in to a steam.

- When the new tissue comes under contact, it tears apart and incision takes place.



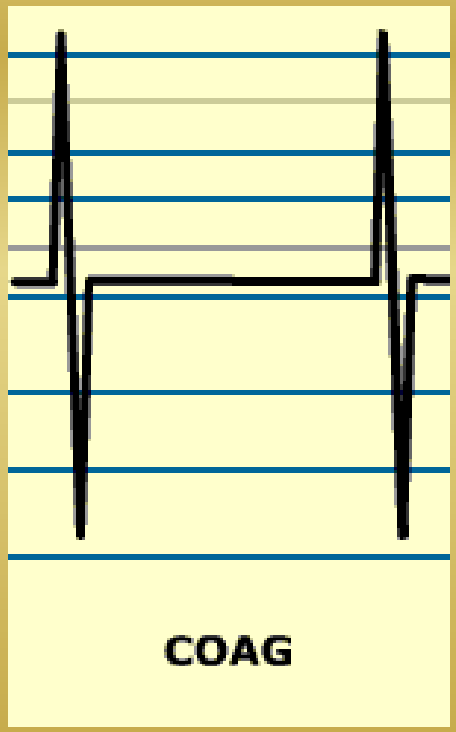
Electrotomy / Cutting

- The RF current applied to the tip of Electrode
- The cutting waveform has 100% Duty Cycle



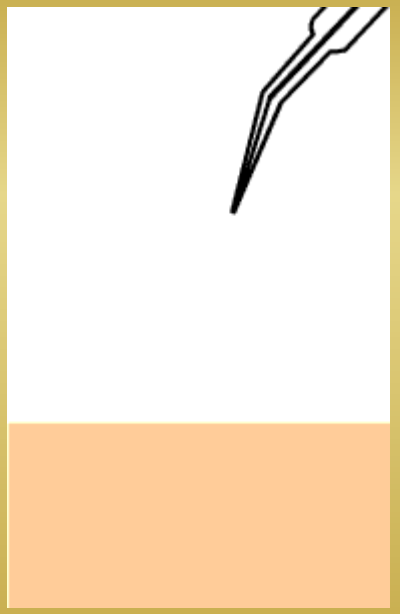
Desiccation (Coagulation)

- In this mode ,needle or ball electrode is kept steady inside the tissue.
- When RF current flows through the tissue cell, it becomes hot and water evaporates slowly so cell plasma gets coagulated.

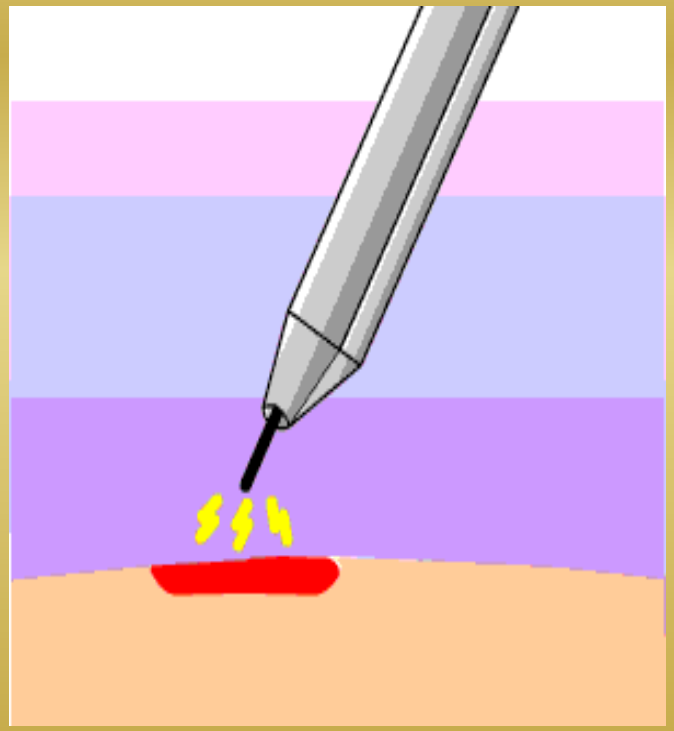


Desiccation (Coagulation)

- Coagulation By Needle Electrode or Ball Electrode can be achieved
- Factor consideration - Intensity and duration of Current



Fulguration

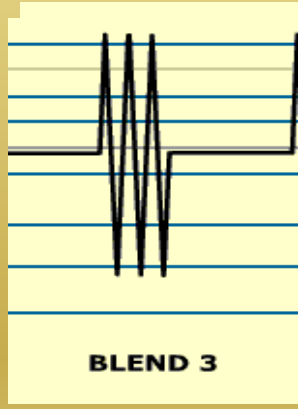


- There is no contact between Active Electrode and target tissue. But electrode is close enough to generate the spark.
- It is a process of Coagulation. Dehydration of cell takes place with sparks.
- Only 6% of duty cycle is used to produce the heat.

Blend Waveform

- It is a combining characteristics of cutting and coagulation waveform that results in cutting with moderate hemostasis.

- 50% ON & OFF 40% ON & 60% OFF 25% ON & 75% OFF



Impact of Tissue

In addition to waveform and power setting, other variables impact tissue effect. They include:

- Size of the electrode: The smaller the electrode, the higher the current concentration. Consequently, the same tissue effect can be achieved with a smaller electrode, even though the power setting is reduced.
- Time: At any given setting, if, ESU is activated for longer time, more heat is produced. This heat can be dispersed to the adjacent tissue.

Power Settings

- The power settings for various procedures varies from one user to another, as different surgical techniques are used with different electrodes
- **Monopolar**
  - Low Power
    - Oral surgery
    - Dermatology
    - Polypectomy
    - Plastic surgery
    - Neurosurgery
    - Vasectomies
    - Hand surgery

Power Settings

- Medium Power
  - Orthopedic surgery
  - Normal thoracic
- General surgery
  - Head/neck/ENT surgery
  - Vascular surgery
  - Transurethral resections (using fine loops)
- High Power
  - Transurethral resections (using ball ends and thicker loops)
  - Thoracotomies for heavy coagulation

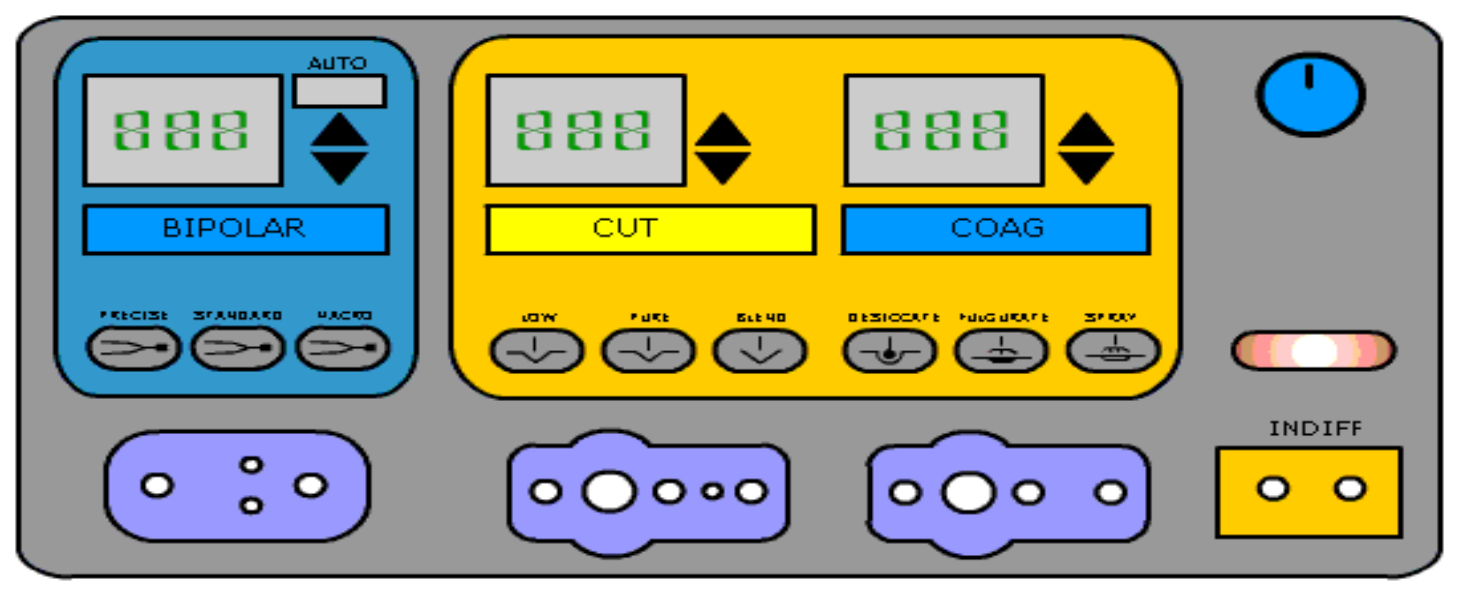
Power Settings

- ***Bipolar***
  - MICRO-BIPOLAR (up to 15 watts output)
- Low Power
  - Eye surgery
  - Fine neurosurgery
- Medium Power
  - Neurosurgery
  - Fine plastic surgery
- High Power
  - Hand surgery
  - Plastic surgery

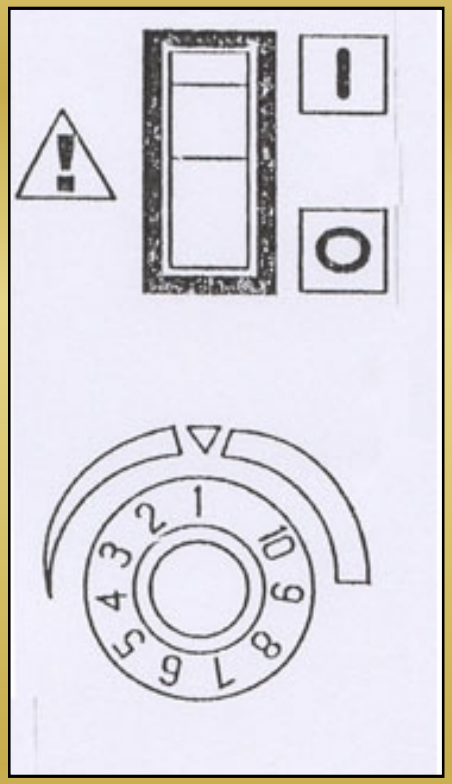
Power Settings

- **MACRO-BIPOLAR** (up to 50 watts output)
- Low Power
  - Hand surgery
  - Plastic surgery
- Medium Power
  - General surgery
- High Power
  - Orthopedic surgery

Operation

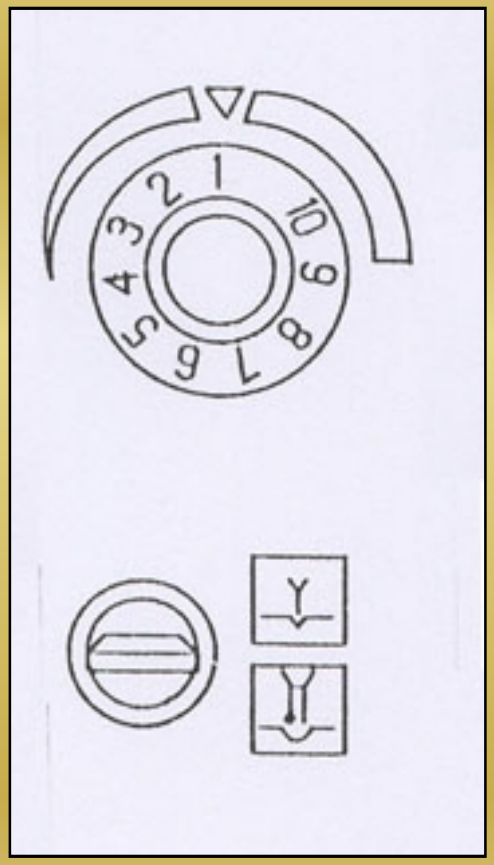


Front Panel



- On/Off Switch – To switch ON and Off the ESU.
- Coag Dial – Clock wise rotation of dial to increase the output gradually

Front Panel



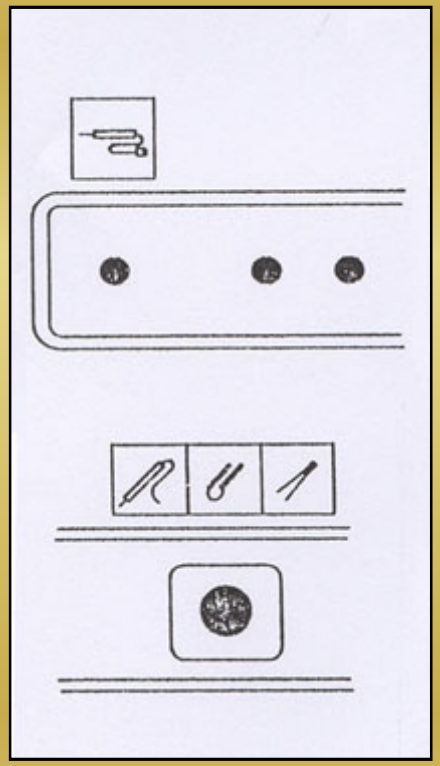
- <u>CUT Dial</u> – To increase the current density to cut a tissue.

- <u>Pure / Blend Selector</u> – Switch or key to select the type of cutting current, either PURE for minimum hemostasis or BLEND for average hemostasis while cutting.

Indicator

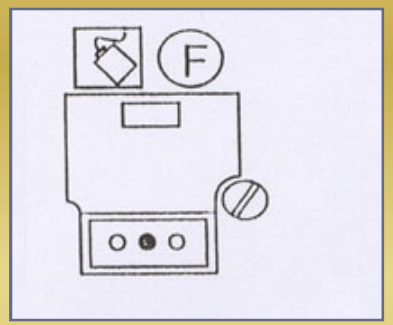
- COAG Mode – Indicator illuminates blue when activating the output.
- CUT Mode – Indicator illuminates yellow when CUTTING (Pure or Blend) is selected.
- Patient Return Electrode fault Indicator- for poor patient contact alarm

Front Panel

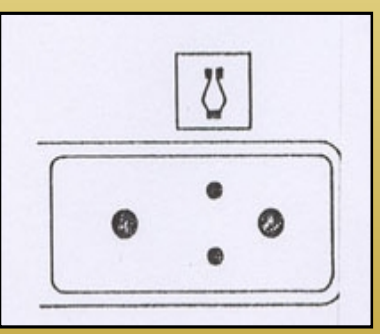


- **Monopolar Receptacle – It will accept three pin hand switch forcep. Only hand switch mechanism will work.**
- **Monopolar Receptacle – Standard receptacle for accessories. It will activate only if footswitch is connected.**

Front Panel



- **Patient Return Electrode Receptacle – The two pin connector to attach patient return electrode in Monopolar procedure**



- **Bipolar Receptacle – It accepts three pin receptacle for bipolar electrode. This will activate with and without footswitch.**

Rear Panel

- **Foot Switch Receptacle** – It accepts monopolar footswitch connector.
- **Audio volume Control** – The tone volume can be adjusted for Cut, Coag and Bipolar mode.
- **Equipotential Lug** – It may be connected to earth ground with a cable.

Operation

Visual Inspection

- Check continuity and condition of power cable, plugs and Accessories cable.
- Check for any crack, insulation break , frayed cable
- Generator tone should be at an audible level
- Check instrument for proper functioning before operation.

Functional Test

- Attach footswitch to rear panel or to the ESU receptacle end.
- Attach Power Cord to AC plug.
- Put ‘ON’ the main switch of ESU.
- Wait for self test to pass.
- Connect Monopolar / Bipolar Electrode and cable to respective connector.
- Switch ‘ON’ the High Frequency by means of pressing footswitch or handle switch.
- Increase the ‘Energy Level’ and look for audible sound and visual light indicator.
- Confirm all the time lowest power setting and confirm with surgeon.

Keep in mind.....

- Always prefer lowest power setting and confirm with surgeon.
- Do attend for checking audible and visual signal.
- Patient Return Electrode is not required for Bipolar mode.
- Sparking at active electrode is a common occurrence.
- There is no guarantee for where the current flows or where other tissue being affected.

Spark Gap Generator

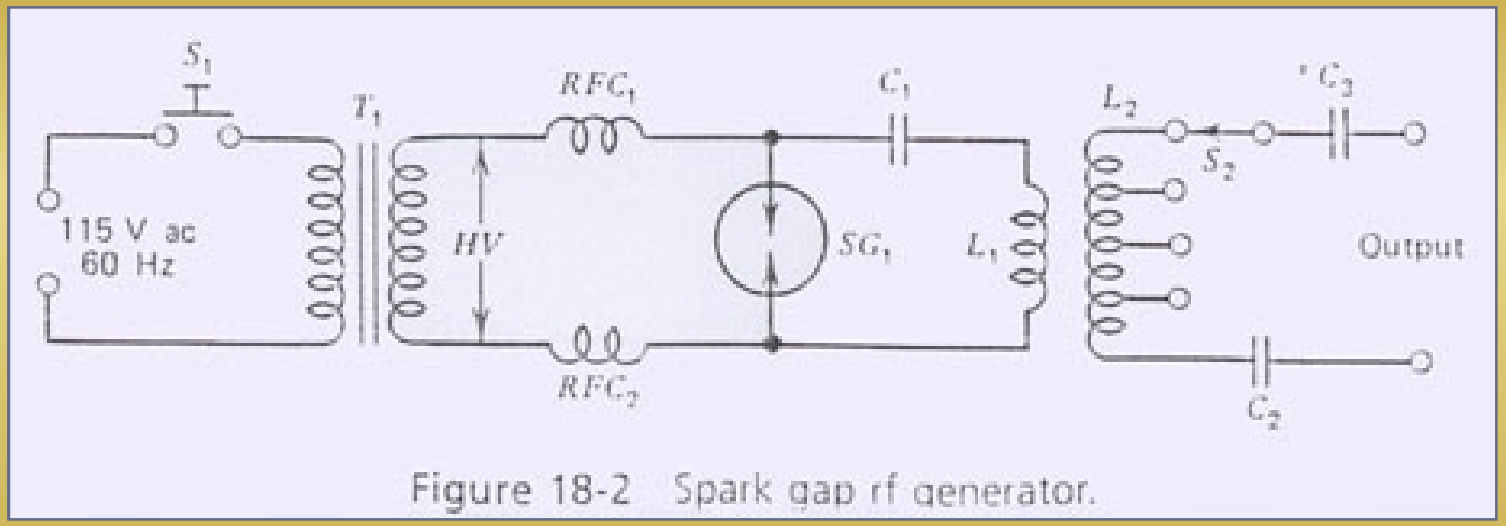


Figure 18-2 Spark gap rf generator.

Solid State Oscillator

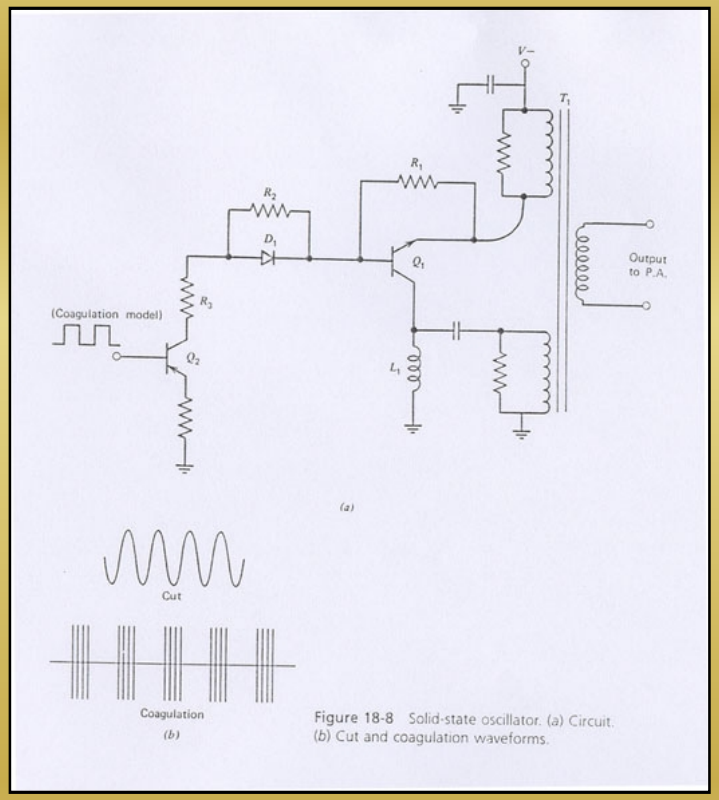
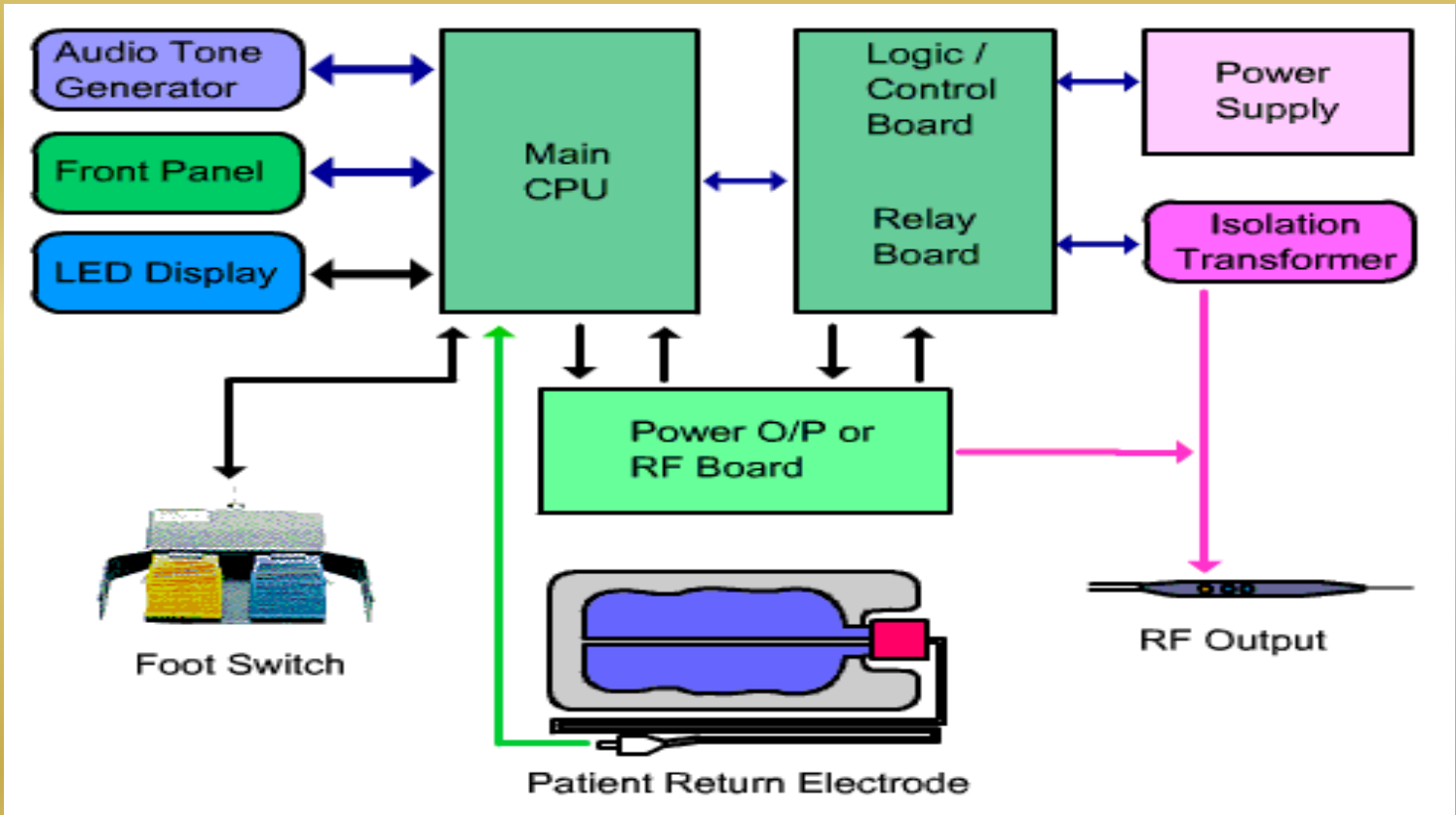


Figure 18-8 Solid-state oscillator. (a) Circuit. (b) Cut and coagulation waveforms.

General Block Diagram



Power Supply

The power supply generates the supply of +5VDC, -5VDC, +15VDC, -15VDC, +24VDC, which is supplied to all units. It is basically like a low voltage power supply. The 5VDC are used for the front panel control and Display. It also monitors the generated voltage for diagnostic purpose to measure the current drawn from power supply.

Power Supply

- **RF output Board** – It has a power amplifier assembly, which comprises with Bipolar, Monopolar, CUT/ COAG and BLEND waveform.

- The output circuit is fully isolated. It generates the out put as per front panel instruction given to Main Board and Logic Control Board.

Power Supply

- It generates the Switch mode pulse pattern generator, Drive circuit for output switching power MOSFETS and High Frequency filtering components.

- In enhanced type generator, the output power is managed and controlled according to patient's tissue impedance

- **Memory Board** – The function of this board is to accept operating mode control signal from front panel, rear panel and foot switch.
- It checks and identifies that which connector is in use and monitors its continuity.
- Interfaced Front Panel switch signals decode and passes information to Display.

Memory Board

- It has a microprocessor, used together with EPROM as program memory and RAM.
- The analog to digital conversion of signal to convert the commands received from front panel and fed to logic board.
- It also generates the audible command whenever any fault occurs during self-test and operation. It detects all front panel operation and acts as per instruction

- **Logic Board / Relay Board** – The board is mainly interfaced with Main Board or sometimes all functions of Main Board are incorporated.
- It is a liaison between front panel and output required. All signals are inter-related to this board.
- It gives the power output command to RF or Power output board and monitors the output. It has relay board too, which activates according to finger switch or foot switch control.

- **Front Panel** – It consists of membrane keyboard, Power switch, Patient Return Electrode, Monopolar, Bipolar connector.

- Front panel also interfaces with Display Board and Power Supply Board. The Power Supply Switch supplies the AC mains current to the Electrosurgical Unit.

- **Display Board – It is located in the Front Panel Assembly. It contains RF indicator lamp, Seven segment LED, Monopolar / Bipolar mode of surgery.**

- **The RF indicator lamps are used for visual indication of presence of RF power during activation. The improper attachment of Patient Return Electrode is visually indicated by Patient Return LED.**

- **It also contains LED driver circuit and Seven Segment Display, which indicates the Bipolar, Monopolar, Cut, Coagulation power settings.**

- **Audio Tone Generator** – It receives the command from Main board, which activates the Audio oscillator circuit.
- Audio circuitry gets ON at time of activation of high frequency, any malfunction or Fault of ESU, improper or loose attachment of patient Return Electrode and Power up.
- It activates with signals provided by micro-controller and gives high and low tone.

Isolation Board

- The patient interface board is interfaced with the Main Board. It has several different functions, which is concerned with patient connected parts and provides the patient isolation voltage.
- It monitors the patient plate continuity, plate voltage, BIPOLAR forceps switch, CUT / BLEND, and COAG finger switches and patient earth monitor.
- It monitors the high frequency leakage current. This board passes the Active electrode signals to main board and continuously monitors the patient plate continuity. If any break occurs in plate lead or not plugged IN, the related signal activates and passes to main board to generate audible signal.

Safety

General Safety

- High Frequency (Sometimes referred to as radio frequency or HF) surgery can result in serious injuries to patient if carelessly or incorrectly applied. HF surgical instrument should be used on patient exclusively by personnel familiar with feature and operation of the equipment.

- In order to prevent accidental injuries due to fault, failure to equipment or its accessories, the equipment and its accessories should be regularly checked for proper and safe operation.

- Electrodes and cables are to fasten carefully.

Safety

Hazardous electrical out put

- Electrosurgical unit is recommended to use only by qualified medical personnel. To avoid burns, do not touch active electrodes.
- Do not operate in explosive atmosphere
- To avoid explosion, do not operate unit in an explosive atmosphere.
- Prevent Electrosurgery use in the presence of flammable gases, flammable liquids, or flammable objects

Electrical Safety

- Electrosurgical units may cause interference with improperly shielded medical equipment.
- **Use proper power cord.**
  Use only a power cord in a good condition with properly grounded receptacle.
- **Use the proper fuses**
  To avoid fire hazard, use only fuses of correct type, voltage rating and current rating as specified. Remove the power cord during replacement of fuse.
- Do not touch the active electrode to grounded metal parts or to the patient plate for function proving.
- The cables to HF-electrodes should be as short as possible and must be arranged without loops so that they touch neither the patient nor other cables. Only cables recommended by the manufacturer should be used.
- Foot switches used in explosion hazard areas must be explosion proof.

Patient Safety

- Ensure that there is no air gap between patient's body and patient return electrode.
- Ensure that no small-surface area contact is made between the patient and any of the metal parts of the treatment chair, table, saline water stand, which conduct ground potential. Heat may be generated at such points leading to undesired burns.
- The patient plate shall be reliable in good contact with the patient's skin for the whole operation;
- If patient plate is fastened at limbs, Be careful that it doesn't affect the supply of blood.

Patient Safety

- The return path of the HF-current shall be as short as possible and in longitudinal or diagonal direction of the body. It should not go transversely through the body, especially at the thorax.
- The patient with pacemaker should be treated and consulted through cardiology department as the high frequency may affect or damage to the pacemaker. Outpatient with pacemakers should not be treated using a HF generator.
- Avoids skin to skin contact, such as fingers touching the patient's leg, when ESU is activated.

Patient return Electrode safety precautions

- Discard the disposable packages that have expired.
- Use ‘Patient Return Electrode’ according to the manufacturer’s documented instruction.
- Inspect patient return electrode before each use for wire breakage or fraying.
- Select appropriate size patient return electrode for patient (i.e, neonate/infant, pediatric, adult).
- Do not cut patient return electrode to accommodate patient size.
- Shave, clean and dry at application site as needed.

Patient return Electrode safety precautions

- Place patient return electrode on positioned patient on a clean, dry skin, convex area in close proximity to operative site.
- Avoid bony scar tissue, skin over an implanted metal prosthesis, hairy surfaces, pressure points, tissue, and areas where fluid may pool.
- Apply finger pressure to adhesive border of the electrode and massages entire pad area to ensure adequate contact with the patient's skin.

Patient return Electrode safety precautions

- Follows manufacturers' guidelines for alarm system, check prior to use.
- Check patient return electrode connections to confirm that they are clean, intact, and can make effective contact.
- Remove patient return electrode gently to protect skin.

Active Electrode safety precautions

- Avoid coiling, bundling, or clamping of active and patient return electrodes.
- Avoid wrapping the active electrode cord around a metal instrument.
- Remove all metal patient jewelry to prevent current diversion and to avoid contact with other metals.
- Place active electrodes in a non-conductive holster designed to hold electrosurgical pencils and similar accessories, when they are not in use.

Active Electrode safety precautions

- Activate electrode mode and function.
- Keep active electrode free from debris
- Record placement of patient return electrode, identification number of unit, and settings used.
- Inspect insulation on reusable and disposable electrodes before and after use

Preventative Maintenance

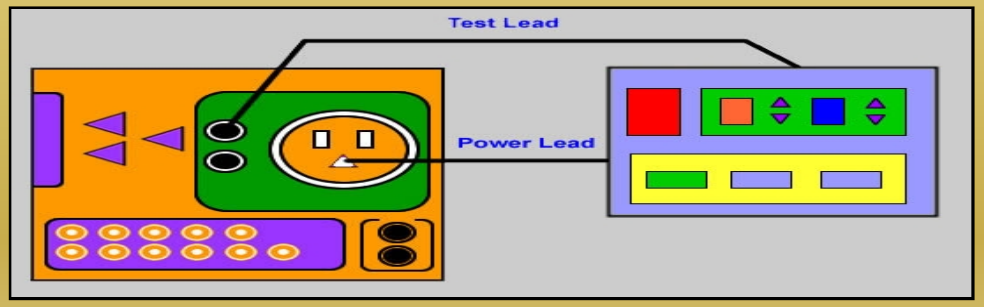
- **Chassis / Housing** - Check Exterior of unit for cleanliness and general physical condition. Be sure that plastic housings are intact, that all hardware is present and fitting are firm and tight, and that there are no signs of spilled liquids.
- **Mount / Fasteners** - If the device is mounted on a stand or cart, examine the condition of the mount. If it is attached to a wall or rests on a shelf, check the security of this attachment.
- **AC Plug / Receptacles** – Check AC power plug for damage. Attempt to wiggle the blades to check that they are secure. Shake the plug for loose screws. If any damage is suspected, open the plug and inspect it. Check the fuse and fitting position.
- **Line Cord** - Inspect the cord for damage & excessive bending. If damaged, replace the entire cord. Verify the minimum power cord length before cutting the defective position.
- **Strain Relief** - Examine the strain relief at both ends of the line cord. Be sure that they hold the cord securely.
- **Circuit Breaker / Fuse** - If the device has an external circuit breaker, check that it operates freely. If the device is protected by an external fuse, check its value and type against that marked on the chassis and ensure that a spare is provided.

Preventative Maintenance

- **Connectors –** Examine all cables of the ESU for proper fittings and firm contact of connectors.
- **Probes -** Confirm that probes for their physical condition. For disposable probes check expiry date.
- **Controls / Switches** - Examine all controls and switches for physical condition, secure mounting, and correct motion. Look for loose connections. Check for proper alignment, as well as positive stopping. Confirm the functioning of each switch and controls proper functioning.
- **Indicators / Displays** - Confirm the operation of all indicators on the unit that all segments of a digital display function and functioning of Alarms.
- **Audible Signal** - Operate the device to activate any audible signals.
- **Labeling -** Check for necessary labels, and instruction cards are present.
- **Dispersive Electrode cable continuity** – Check the patient return electrode continuity and any alarm functioning on removal.
- **Accessories (Footswitch)** – To check the physical integrity, connection and proper operation of all accessories related to ESU

Safety Test Procedure

- Switch on the safety analyzer and connect the Test lead between ENCL and EARTH
- Press set up in the main menu.
- Press ‘CAL’ in the system set up.
- Press “Calibrate Test Lead Enclosure/Ground.
- The test results are displayed once the Calibration is complete.
- Connect the Main Plug of the Electrosurgical Unit (ESU) to the Safety Analyzer Terminal on the front panel.



Safety Test Procedure

- Connect the calibrated Test lead between ENCL on the Safety Analyser Terminal to the Chassis or the ground terminal of the Electrosurgical Unit (ESU).
- Ensure that the main switch on the Electrosurgical Unit (ESU) is switched ‘ON’.
- In the main menu, press Equipment Code and enter the Asset number of the ESU.
- Press Equipment Classification and select classification.
- Press Start in the main menu to start the test.
- Once the Electrical Safety Test is over, print the test result.

Quantitative Test

- Connect the Electrosurgical Unit to the Electrosurgical Analyzer and verify output power generated by ESU. Procedure to check Output

  - Power up the Electrosurgical Analyzer and wait for self test to pass.
  - Attach the Monopolar Electrode and patient return electrode to the ESU.
  - Connect and hold Active electrode with crocodile pin to the Electrosurgical analyzer jack, similarly connect the patient return electrode.
  - Put ‘ON’ the ESU analyzer and wait for self test to pass.
  - Once the Main display appears select the particular load (e.g. 500)
  - Put ‘ON’ the ESU and wait to complete the self-test.

Quantitative Test

- Select **CUT mode** and minimum power out put energy on Monopolar by pressing UP and DOWN arrow key.
- Press the Hand switch or foot switch to get the output.
- Note the audible sound and measured power output. Selected Output on ESU and Displayed output on ESU analyzer should be same or with in range of tolerance.
- Select the different power and note down the readings. (If it differs refer service manual for calibration)
- Similarly check for **COAG** mode.
- Check for **Bipolar** mode.

Troubleshooting

- Servicing Techniques
- Service Manual
- Guess or Judge
- Step by step procedure to troubleshoot.

Troubleshooting

USER CHECKLIST

- Check the Electrosurgical Unit (ESU) for physical damage.
- Verify all accessories cords are connected properly.
- Check the condition of power cord, it should not be frayed, damaged, crack or exposed of any wire otherwise replace the same immediately.
- Check the fuse of ESU. It should be firmly fitted inside the fuse socket. Also check for any corrosion and damages if so replace the same rating of fuse as mentioned in manual and on ESU.

Troubleshooting

- Disconnect the *power cord* and check for *Footswitch* receptacle damage or obstruction. If found replace the rear panel or rear panel connector.
- Check for the firm contact of *Bipolar* Instrument receptacle on front panel for obstruction and damage. If found replace the front panel or front panel connector.
- Check for the firm contact of *Monopolar* instrument receptacle on front panel for any obstruction and damage. If found replace the front panel or front panel connector.
- Check the *patient return electrode* receptacle for any broken pins and obstruction. If found replace the front panel or front panel connector